

Rare conifers from the type area of the Maastrichtian (Upper Cretaceous, southeast Netherlands)

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Two conifer twigs from the type area of the Maastrichtian are described as *Brachyphyllum* sp. 1 and *Brachyphyllum* sp. 2. They might belong to the Cheirolepidiaceae, Podocarpaceae or Taxodiaceae. *Brachyphyllum* sp. 1 occurs with the conifers *Brachyphyllum patens* (?Cheirolepidiaceae) and *Elatidopsis cryptomerioides* (Taxodiaceae), the seagrass *Thalassocharis bosqueti* and the ammonite *Baculites vertebralis* in the upper part of the Kunrade Chalk in the Kunrade area, while *Brachyphyllum* sp. 2 probably originates from the lower part of this deposit.

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Introduction

The Maastrichtian limestone deposits of the type area (southeast Netherlands, northeast Belgium and adjacent parts of Germany; Figs. 1, 2) are very poor in plant macrofossils, in comparison to the rich underlying Santonian sands and clays of the Aken Formation. Miquel (1853) described a few Maastrichtian seed plants, including two conifers, *Cycadopsis cryptomerioides* (*Elatidopsis cryptomerioides*; van der Ham *et al.*, 2001) and *Pinites patens* (*Brachyphyllum patens*; van der Ham *et al.*, in press). The former belongs to the Taxodiaceae, while the latter is tentatively assigned to the Cheirolepidiaceae. Van der Ham *et al.* (2001) described the taxodiaceous conifer *Cryptomeriopsis elwialis*. Four other conifers are known from the area, two *Brachyphyllum* species, a *Cunninghamites*-like species (van der Ham & van Konijnenburg-van Cittert, 2002; van der Ham *et al.*, 2002) and a *Pagiophyllum* species (van der Ham & van Konijnenburg-van Cittert, in press). All four are known from single specimens only. The present paper deals with the two *Brachyphyllum* species, as part of the ongoing study of fossil plants from the Maastrichtian type area.



Fig. 1. Map of the type area of the Maastrichtian, showing the locality (Kunrade) where *Brachyphyllum* sp. 1 and *Brachyphyllum* sp. 2 were collected.

Material, geography and stratigraphy

The material of *Brachyphyllum* sp. 1 belongs to the collections of the Nationaal Natuurhistorisch Museum, Leiden (RGM 21444; Staring Collection no. 5206). It was collected in 1853 in a limestone quarry near Kunrade, a few kilometres southwest of Heerlen (Fig. 1). The limestone belongs to the Kunrade Chalk (Fig. 2), which is the easterly (more coastal) facies of portions of the upper Gulpen and lower Maastricht formations (Upper Maastrichtian, *Belemnitella junior* Zone). The specimen is a three-dimensional impression of a single twig in an indurated limestone matrix, and shows the same kind of preservation as *Elatidopsis cryptomerioides* and *Brachyphyllum patens*. Associated with it are the seagrass *Thalassocharis bosqueti* Debey ex Miquel, the ammonite *Baculites vertebralis* Lamarck, several bivalves, a gastropod species, and fragments of bryozoa and serpulids. Probably, the material originated from the upper part of the Kunrade Chalk.

The material of *Brachyphyllum* sp. 2 belongs to the collections of the Natuurhistorisch Museum, Maastricht (NHMM 3639), and was collected in 1926 in the Kunrade area, probably from the more sandy lower part of the Kunrade Chalk ("quartz- and glauconite-rich beds" *sensu* Francken, 1947). It consists of three-dimensional impressions of three twigs in a matrix of strongly cemented quartz grains, in which also occur impressions of up to 36 mm large, unidentified pieces of wood (earlier identified as *Thalassocharis*).

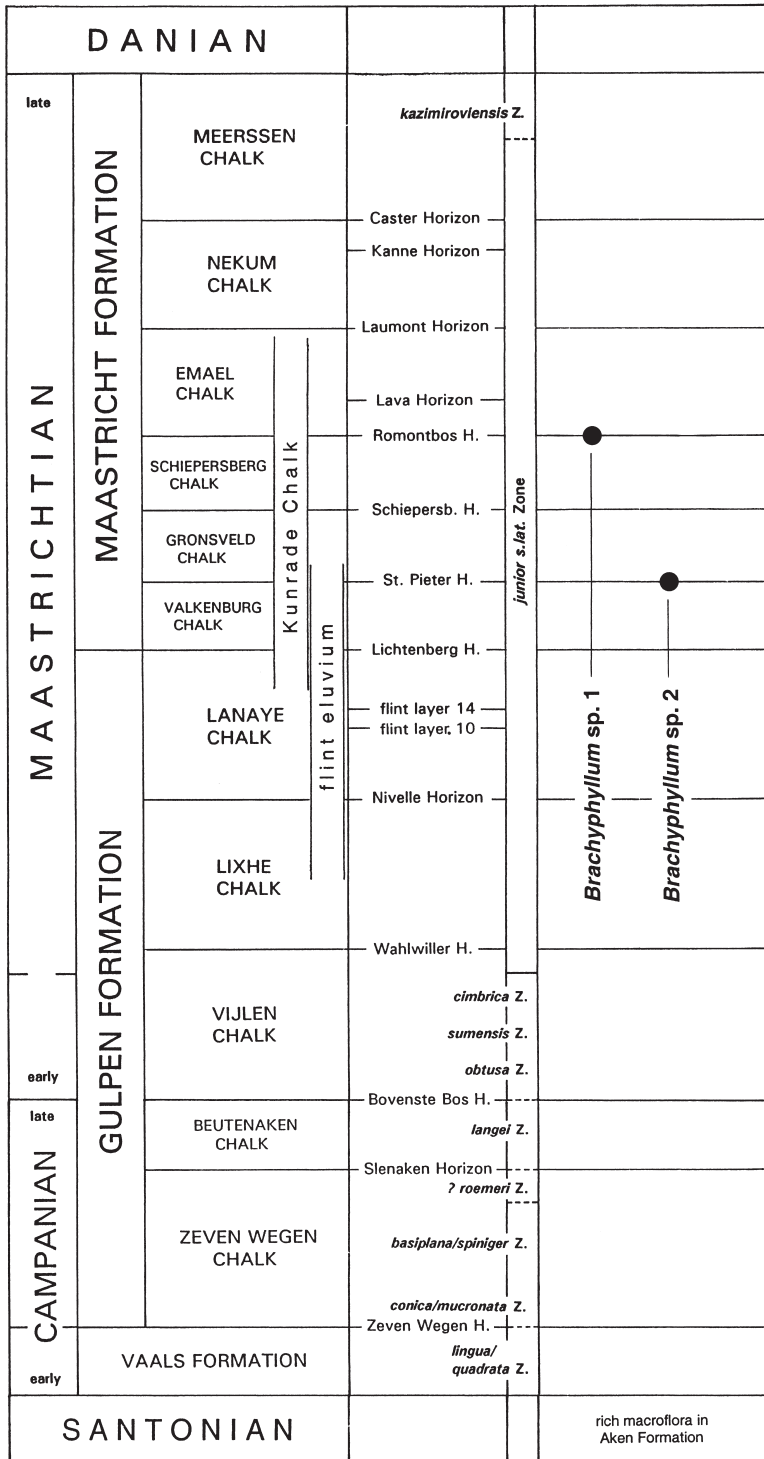


Fig. 2. Stratigraphy of the Cretaceous deposits in the type area of the Maastrichtian, showing the approximate origin of the material of *Brachyphyllum* sp. 1 and *Brachyphyllum* sp. 2, and the stratigraphical position of the macroflora in the Aken Formation. See Jagt (1999) for further stratigraphical details

A rubber cast (Pl. 1, fig. 2) of the RGM 21444 specimen was prepared according to the method described by Indeherberge *et al.* (1998), using silicone rubber of the brand Wacker M45-Elastosil®M. In contrast to earlier cast methods described (see, e.g., Watson & Alvin, 1976), a vacuum pump was used to extract the air bubbles from the rubber. Without any preparation of the surface of the impression, a peel (Pl. 2) was taken from the largest twig in NHMM 3639.

The camera-lucida drawings (Fig. 3) were made with a Wild M5 stereoscope. The scanning electron micrographs were produced with a Jeol JSM-5300 scanning microscope, using a Bal-Tec SCD 005 sputter coater.

Systematic palaeontology

Brachyphyllum Lindley & Hutton 1836
ex Brongniart 1828, emend. Harris 1979

Brachyphyllum sp. 1

Pl. 1, figs 1, 2; Fig. 3a.

2002 *Brachyphyllum* sp. - van der Ham *et al.*, p. 8.

2002 *Brachyphyllum* sp. - van der Ham & van Konijnenburg-van Cittert, p. 178.

Material — RGM 21444, from the Kunrade Chalk in the Kunrade area.

Description — Twig unbranched, 52 x 5 x 3.5 mm, slightly flattened (probably by compression). Leaves spirally arranged, scale-like, imbricate, 3.2-6.8 mm long, becoming larger towards the top, probably single-veined (based on the observation of a single scar in a broken leaf base). Cushions ± rhomboidal, 2.4-3.2 mm wide. Parastichy numbers 3 (clockwise) and 2 (counterclockwise). Free leaf portion appressed, 1.2-2.8 mm long and 2.4-3.2 mm wide, always shorter than the width of the cushion; abaxial side convex, with an obtuse, but distinct, longitudinal keel; adaxial side slightly convex; margins entire, sharply edged; apex slightly falcate, acute. Cuticular features not preserved.

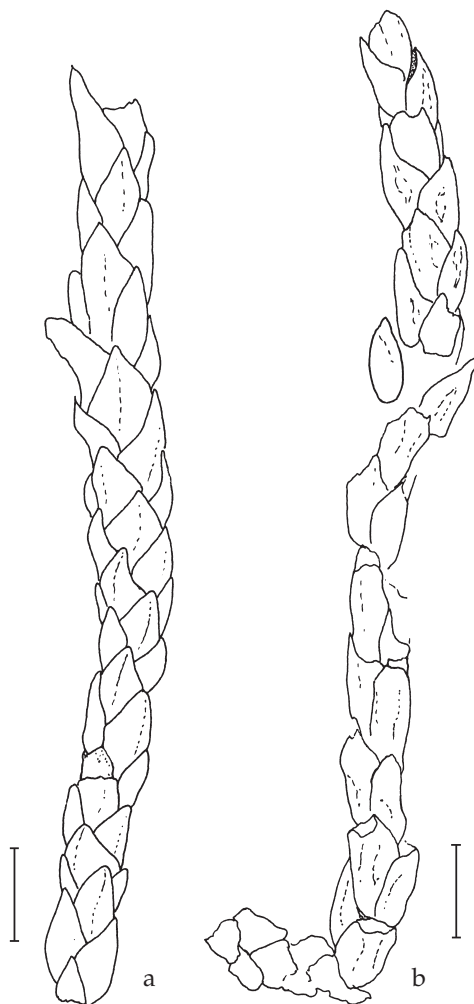


Fig. 3. Camera-lucida drawings of *Brachyphyllum* from the Kunrade Chalk at Kunrade. (a) *Brachyphyllum* sp. 1, rubber cast of RGM 21444, showing spirally arranged, scale-like, appressed, imbricate leaves. Scale bar represents 5 mm. (b) *Brachyphyllum* sp. 2, peel of largest twig in NHMM 3639, showing spirally arranged, scale-like, appressed, imbricate leaves. Scale bar represents 2 mm.

***Brachyphyllum* sp. 2**

Pl. 2, figs 1, 2; Fig. 3b.

Material — NHMM 3639, from the Kunrade Chalk in the Kunrade area.

Description — Twigs unbranched, 4.5, 5.5 and 24.0 mm long, and 1.5 mm wide. Leaves spirally arranged, scale-like, imbricate, 1.1-2.3 mm long, small at the base, amphistomatic. Cushions ± rhomboidal, 0.9-1.4 mm wide. Parastichy numbers 1 (clockwise) and 2 (counterclockwise). Free leaf portion appressed, shorter than the width of the cushion; abaxial side convex, with an obtuse, longitudinal keel; adaxial side slightly convex; margins entire, sharply edged; apex slightly falcate, acute. Stomata at abaxial side arranged at both sides of the keel, randomly or locally in indistinct rows, at adaxial side sparsely present (two zones?). Stomatal pits *c.* 30 µm wide.

Discussion

Both species are assigned to the morphotaxon *Brachyphyllum* because the leaves are spirally arranged and have a free leaf portion shorter than the width of the cushion (Harris, 1979). It is not excluded that, if more material would become available, *Brachyphyllum* sp. 1 and *Brachyphyllum* sp. 2 could turn out to be conspecific; see, for instance, Seward (1919, fig. 810) and Srinivasan & Friis (1989, pl. 1, fig. 1), who illustrated small-sized conifer twigs attached to much thicker ones. *Brachyphyllum*-type leaves occur in Araucariaceae (*Araucaria*), single-veined Podocarpaceae (multiveined members have narrowly attached leaves), Taxodiaceae and the non-frenelopsid members of the extinct family Cheirolepidiaceae (Axsmith *et al.*, 1998; de Laubenfels, 1953; Harris, 1969; Watson, 1988). Araucariaceae is least likely, as no pollen of this family has been found so far in the Maastrichtian of the area, whereas pollen of Podocarpaceae (*Podocarpidites* spp.), Taxodiaceae (*Inaperturopollenites* spp.) and Cheirolepidiaceae (*Classopollis*) is more or less common (Kedves & Herngreen, 1980; Herngreen *et al.*, 1986; Herngreen, 1998; van der Ham *et al.*, in press). Because cuticular features are not preserved, further assignment of *Brachyphyllum* sp. 1 to one of the remaining families is impossible. At least superficially, *Brachyphyllum* sp. 1 resembles the extant *Athrotaxis cupressoides* D. Don (Taxodiaceae) from Tasmania (see, e.g., Kunzmann, 1999, pp. 25, 143).

Brachyphyllum sp. 2 resembles *Quasisequoia* (Taxodiaceae) from the Upper Santonian or Lower Campanian of southern Sweden, especially *Q. florinii*, which has similar leaves, also with scattered stomata (Srinivasan & Friis, 1989; Kunzmann, 1999). However, as further cuticular features are lacking, *Brachyphyllum* sp. 2 cannot be reliably attributed to this genus.

Brachyphyllum sp. 1 occurs together with the conifers *Brachyphyllum patens* (?Cheirolepidiaceae), *Elatidopsis cryptomerioides* (Taxodiaceae) and long (at least 36 mm) detached conifer needles in indurated limestone (Kunrade Chalk) in the Kunrade area. In addition, two specimens of a conifer tentatively identified as *Cryptomeriopsis eluvialis* (Taxodiaceae) are known from the Kunrade Chalk in the Kunrade area; RGM 13434 + 21404 (counterparts) and Kruit Collection (RGM unregistered). Compared with the western Gulpen and Maastricht formations, it appears that the upper Kunrade Chalk, which is the easterly (more coastal) facies of these deposits, gives a

better impression of the conifer vegetation of the nearby (easterly) land, from which the above species were probably washed into the shallow Late Maastrichtian sea.

The lower part of the Kunrade Chalk is a coastal deposit. The quartz grains in the matrix surrounding the twigs of *Brachyphyllum* sp.2 are assumed to belong to a primary deposit derived from the sandy Vaals Formation eroded from the nearby coast (Francken, 1947). More land plants are expected if the relatively unknown quartzitic beds are more thoroughly searched for fossils.

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Plate 1

Brachyphyllum sp. 1, RGM 21444 (Kunrade, Kunrade Chalk). Scale bar represents 5 mm.

Fig. 1. Impression of the leafy twig.

Fig. 2. Portion of the rubber cast, showing spirally arranged, scale-like, appressed, imbricate leaves, each with an obtuse, longitudinal keel.



Plate 2

Brachyphyllum sp. 2, largest twig in NHMM 3639 (Kunrade, Kunrade Chalk).

Fig. 1. Portion of the peel, showing spirally arranged, scale-like, appressed, imbricate leaves, each with an obtuse, longitudinal keel. Scale bar represents 1 mm.

Fig. 2. Leaves, showing scattered stomata besides the median obtuse keel, locally in an indistinct row. Scale bar represents 100 μm.

